

Environmental Engineering
Energy Conservation

JOSEPH GOLDFIELD
Engineering Consultant

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129 Elm Street
Denver, Colorado 80220
(303) 321-7276

1990 NOV 21 A 7 51

November 20, 1990

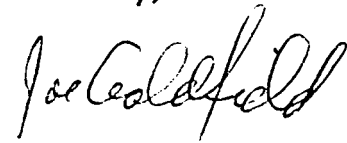
Ms. Beth Brainard
Department of Energy
PO Box 928
Golden, CO 80402-0928

Dear Beth,

I am enclosing my comments on the Proposed Interim Remedial Action Plan to treat surface water run-off from OU 2. I hope that they will be found helpful in reducing exposures to people at Rocky Flats, construction workers and to the communities receiving water from the drainage area of OU 2.

Many of the issues raised in my comments are similar to those discussed in my comments on 881 Hillside Cleanup. I am therefore including a copy of that report with my present comments. Even though repetitive, I feel strongly that my comments must be considered to insure safe conditions for the workers at Rocky Flats and for the community downwind and in the drainage area from OU 2.

Sincerely,



Joe Goldfield

ADMIN RECORD

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A-OU02-000141

U.S. DEPT. OF JUSTICE
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COMMENTS ON

PROPOSED SURFACE WATER

Interim Measures/Interim Remedial Action Plan

903 PAD, MOUND, and EAST TRENCHES

JOSEPH GOLDFIELD
CONSULTING ENGINEER

129 ELM STREET
DENVER, COLORADO
November 19, 1990

Comments on**Proposed Surface Water Interim Measures/Interim Remedial Action Plan****903 PAD, MOUND, and EAST TRENCHES****INTRODUCTION**

The 903 Pad and Lip Area, Mound, and East Trenches Area have been designated Operable Unit No. 2 (hereinafter referred to as OU 2). OU 2 is very heavily contaminated with a large number of volatile organic compounds (VOC), metals, inorganic materials, radionuclides and semi-volatile organic compounds. It is difficult to make a complete count of the numerous contaminants of significance. There are at least 15 VOC, 20 metals, 5 inorganic materials, 7 radionuclides and 4 semi-volatile organic materials found in the soils or drainage system from (waters and sediments) OU 2. The over 50 contaminants represent different levels of hazard to the community because of varying toxicity, concentration and degree of mobility into the air and waters moving into the soil, water and air leaving the Rocky Flats plant area. Nevertheless, the toxicity of some the contaminants, particularly plutonium and americium, is of great concern. Almost all the materials cited are present in concentrations above the background level. Many have caused concentrations above the Applicable or Relevant and Appropriate Requirements (ARARs) to be found in the surface waters draining from OU 2.

The degree of contamination in the soils of OU 2 is not accurately known due to the hazards of collecting samples. One of the most poignant but significant descriptions pertaining to that problem appears in Volume 1, page 3-29 . . . "Boreholes were not drilled into sites still containing wastes (the trenches and 903 Pad) due to potential hazards to field workers and potential for release of waste constituents to the environment."

In soils east of OU 2 americium has been found at levels of 97 pCi/g (picocuries per gram of soil), announcing by inference the presence of plutonium at levels of 500 pCi/g of soil. That level for plutonium found in the soil is 500 times as high as the Colorado Department of Health limit of 1 pCi/g. Since the background concentration of plutonium in soil is 0.08 dpm/g (disintegrations per minute per gram of soil) and 2.2 dpm is equal to 1pCi, the concentration of plutonium found east of OU 2 is **14,000 times as high as background.**

The contamination present in the soils of OU 2 is slowly but inexorably moving east into the communities near the Rocky Flats plant, propelled by the wind, groundwater, and surface water runoff.

The proposal in the subject action plan is to clean up the contamination in the surface water runoff from OU 2.

Several issues are raised in these comments--some of which were also raised in comments made concerning the 881 Hillside Cleanup. A copy of those comments are attached to these because the issues are almost identical.

The three issues raised in the 881 Hillside Cleanup comments and almost identical to those applicable to OU 2 are:

1. Workers participating in excavation and drilling must be adequately protected from breathing air carrying contaminated soil particles and from carrying that contamination home to their families on their clothing.
2. The people in areas surrounding Rocky Flats must be adequately protected from the suspension of contaminated soil particles.
3. The planned treatment of the contaminated ground water must consider the presence of over 50 hazardous contaminants present in the soil and water run-off.

In addition, a fourth issue is addressed herein. Why is only the ground water being treated? Why not simultaneously excavate and remove the grossly contaminated, buried wastes in OU 2 that are serving as a focal point source of the contamination finding its way into the water drainage system that moves towards drinking water supplies and to the soils of surrounding communities?

REMOVING BURIED CONTAMINANTS

The elements of OU 2 contain wastes buried by Rocky Flats that are among the more dangerous and heavily contaminated than those disclosed up to now. They are certainly more heavily contaminated than those disclosed in the 881 Hillside Cleanup proposal. The only certain, long-term solution to the problem of contaminated surface water run-off, ground water

contamination, contamination of sediments in the water drainage system from the plant, and to the air borne soil particles blowing towards neighboring communities is to excavate, package and remove the wastes and associated soil. The treatment of water run-off and ground water can continue until the residual contamination that has already escaped from the buried waste falls to "safe" levels.

This proposed solution is so obvious, so certain of success, and so necessary as a long-term solution that it is difficult to see why it is not dealt with in the interim plan.

PROTECTING WORKERS FROM SOIL CONTAMINANTS

The comments from the attached "881 Hillside Cleanup" are equally applicable to the construction work that must be done for the installations of the OU 2 cleanup. It is grossly unfair and possibly criminal to have workers dig in the vicinity of soils that are as dangerous as those described above (quote from page 2-29). The workers and their families must be protected with breathing apparatus, throw-away clothing, change areas, showers, and all the other elements described in OSHA regulations attached to the report in the appendix.

Presence of Di-octyl Phthalate

In this area (OU 2), just as in the 881 Hillside, the most prevalent organic compound found in high concentrations is bis (2-Ethylhexyl) Phthalate. The ubiquitous occurrence of this material in grossly contaminated areas of Rocky Flats requires some explanation. The only guess I can make is that the material named is a synonym for di-octyl phthalate which is used for testing HEPA filters of which 14,000 are reputed to be in use at Rocky Flats. Is it possible that the widespread finding of this chemical is marking the presence of large numbers of dangerously contaminated HEPA filters that are spent and are buried at the site?

PROTECTING THE COMMUNITY FROM FUGITIVE DUST EMISSIONS

The attached report for 881 Hillside Cleanup describes the concerns that are equally applicable to work done for the OU 2 Surface Water Cleanup. All excavation should be done within enclosures described therein that are equipped with exhaust systems to maintain the buildings under negative pressure.

MULTIPLE CONTAMINANTS IN POTABLE WATER

The discussions of remedial action to be taken for removal of the multiple contaminants present in the surface water run-off from OU 2 does not take into account the fact that there are 50 contaminants present. The discussions dealing with removal of each contaminant propose to reduce that contaminant to less than its ARAR (Applicable or Relevant and Appropriate Requirements). That methodology is valid where only one contaminant is present in drinking water; **not where 50 dangerous contaminants are simultaneously present.**

Methods for dealing with this problem have long been known. One is described in the attached 881 Hillside Cleanup report that includes a method used by OSHA (Occupational Safety and Health Administration) for dealing with multiple contaminants in the workplace. A similar method is described in Chapter I--Nuclear Regulatory Commission, Part 20, App. B, page 237, which states:

"NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

"1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix B for the specific radionuclide when not in a mixture. **The sum of such ratios for all the radionuclides in the mixture may not exceed '1' (i.e. 'unity')**"

That rule is identical to the one used by OSHA.

Very similar rules are given in "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)" issued by the EPA.

The only method lacking is how to combine the various contaminants that are labelled *radionuclides, carcinogens, and non-carcinogens*.

There is no justification for disregarding the presence of multiple contaminants. That methodology flies in the face of historical, regulatory

practise; underestimates the degree of removal required for each contaminant; and poses greatly added risk to the population exposed to the treated water.

Some verbal comments have been made that the rule is not applicable to "interim-remedial actions". I don't understand that reasoning since the studies of life-time costing compare costs after 30 years of operation. If "interim" is supposed to embrace a very short term solution, that is certainly not borne out by the 30 year estimate of equipment operation.

APPENDIX

881 HILLSIDE CLEANUP

EXPOSURE OF WORKERS AND THE COMMUNITY

881 HILLSIDE CLEANUP

Exposure of Workers

and the Community

JOSEPH GOLDFIELD
CONSULTING ENGINEER

129 ELM STREET
DENVER, COLORADO
July 6, 1990

DANGERS OF CLEANUP--881 HILLSIDE

The cleanup project of 881 hillside was stopped for some time because several deficiencies were detected in the methods required to ensure safety for the workers and for the public. EGG is planning to restart cleanup very shortly on the assumption that all relevant safety issues have been addressed. That conclusion is far from the truth. There are at least three issues that have never been adequately addressed nor resolved.

The three issues are:

1. Workers participating in excavation and drilling are being inadequately protected from breathing air carrying contaminated soil particles.
2. The people in areas surrounding Rocky Flats are being inadequately protected from the suspension of soil particles that are contaminated.
3. The planned treatment of the contaminated ground water does not consider the problem that there are over 50 hazardous contaminants present in the groundwater of 881 hillside.

PROTECTING WORKERS FROM SOIL CONTAMINANTS

Workers are excavating soil for building foundations and drilling holes along the proposed barrier to contain the ground water runoff. The only protection being provided is to wet the soil, to a moisture content of 15%, to prevent air borne particles from being dispersed into the breathing zone of the men doing the work.

Evidence of Soil Contamination

The soil on the Rocky Flats plant is very heavily contaminated with a very great variety of dangerous materials--not the least of which is plutonium which has contaminated the ground below the 903 pad, among other places. Although over 178 sites have been identified where dangerous contaminants have been buried or leaked into the ground, the record is far from complete. Inadequate records are available as to the materials dumped or the quantities and locations. Anytime the soil is disturbed there is the danger that some previously undisclosed dump or dangerous contaminant may be discovered. That factor is especially true of hillside 881 which may be contaminated with seepage from the 903 pad area.

The Colorado Department of Health has set a standard of 2 dpm/g (disintegrations per minute per gram) as the upper acceptable limit for radioactive contamination of soil. Since 2.2 dpm is equal to 1 pCi (picocurie), the limit is equivalent to roughly 1 pCi/g of soil. The background level (the contamination of soil far removed from the Rocky Flats plant) is only 0.08 dpm/g. The Colorado limit is **twenty-five times** as great as background.

Carl Johnson, in his report in Science, August 1976, "Plutonium Hazard in Respirable Dust on the Surface of Soil" reports that his estimate of background levels in the respirable fraction of surface soil (particles equal to or less than 5 micrometers in size) is 0.45 dpm/g--5.5 times as great as the level of 0.08 dpm/g for total soil.

Bearing in mind the facts discussed in the preceding two paragraphs, please review Enclosure 1--881 Hillside Surface Scrape Sampling Results. The Enclosure is from U. S. DOE, 1990b and appears in a work plan dealing with the 881 hillside area. The results of 19 samples taken on 881 hillside and analyzed for plutonium, uranium 238 and uranium 233 + 234 are presented. Of 19 samples tested for plutonium, 8 are above the Colorado Department of Health guidelines of 1 pCi/g (4.3, 2.4, 4.8, 2.2, 1.8, 3.5, 2.6, 3.0 pCi/g). Bear in mind that the highest reading is **130 times as high as background** and that the respirable fraction of the soil has a reading that is probably 715 times as high as background and almost thirty times greater than the Colorado Department of Health guidelines.

Uranium results are as high as 3000 pCi/g of soil.

A reading taken E-SE and 150 yards from the 903 pad area is reported in the CDH "Environmental Surveillance Report", May 1990. That location is probably above and in the drainage area seeping toward the 881 hillside. The reading reported in Table C shows 186.5 pCi/g of plutonium, **almost 200 times the CDH guideline and 5000 times as great as background**. Please recall that the respirable dust would have 5.5 times as high a concentration.

Americium-241 shows a concentration of 22.9 pCi/g.

For some reason, neither the Colorado Health Department, the Environmental Protection Agency, nor Rocky Flats can detect a threat to workers digging in such soil.

In the text of the October, 1989 "881 Hillside Area--High Priority Sites"

regularly and were the *principal* (my italics) semivolatile contaminant of the soil, particularly bis (2-ethyl hexyl) phthalate (DEHP). The maximum concentration of DEHP in the soil was 7,216 µg/kg. . ." Although a *response by Rocky Flats* to my statement in Comment 58 of comments by the public concerning the 881 hillside cleanup *said that the chemical name given above was not DOP (dioctyl phthalate)* used to test HEPA filters, I am enclosing a copy of a page (Enclosure 2) from the "NIOSH Pocket Guide to Chemical Hazards" issued by the National Institute for Occupational Safety and Health, which lists Di-sec-octyl phthalate with synonyms given as "DOP, bis-(2-Ethylhexyl) phthalate, Di-2-Ethyl-hexyl phthalate, DEHP." Please note that the *synonyms are identical to the description given by Rocky Flats*. The significance of this fact is that DOP is used to test HEPA filters. Finding it as a principal contaminant of the soil in 881 hillside raises the specter of the burial of plutonium contaminated, spent HEPA filters in the 881 hillside.

Coincident with the danger of soil contamination is inadequate airborne sampling and untimely analysis of the samples. One description given of the collection of airborne samples was that one sample would be collected at some distance from one corner of an excavation. Thus, if the prevailing wind were blowing the airborne particles away from the sample location it would not get a representative sample. Even if the wind were blowing away from the sample location only part of the time, the concentration at the breathing zone of the operators would be understated. Additionally, a sample would be taken for two weeks at which time a second two week sample would be collected. At the end of a month's time, the two samples would be combined and the combined sample sent for chemical analysis. A month later an analysis would be finally complete of the contaminant concentration that workers would be breathing for the previous two months.

Suppose that a dangerous concentration was shown to have existed? Will a letter of apology to the family of the worker be issued? You cannot rescind the contaminated air that the worker breathed.

Under these conditions the following must be done to help insure worker safety:

1. Take many more samples. A minimum of six sampling stations should surround and be close to each excavation.

2. It must be assumed that the danger of being overexposed to contaminants for two months exists and that safeguards be established to protect workers from that exposure. Enclosure 4 contains pages taken from the OSHA (Occupational Safety and Health Administration) regulations for asbestos. All the protective gear, including throwaway clothing, effective facemasks, change rooms, medical examinations, and record maintenance must be implemented.

Wetting of the soil to reduce the quantity of air borne dust is inadequate protection and cannot be relied upon to safeguard the workers. Wetting of soil to prevent fugitive dust emissions from mining operations, vehicular traffic, coal piles and the like has been widely practised. Careful testing of the results has established that wetting is only moderately effective in reducing air borne dust emissions.

PROTECTING THE COMMUNITY FROM FUGITIVE DUST EMISSIONS

Two methods have been proposed for protecting the community from fugitive dust generated by construction on the 881 hillside. One is wetting and the other is stopping operations when winds exceed 15 miles per hour for 15 minute periods. The inadequacy of wetting to ensure community protection has already been covered. Enforcing the prohibition against construction when winds are over 15 miles per hour will be quite difficult. Who measures the wind velocity? How is cessation of construction instituted? Who is responsible? How is construction resumed? Who determines that the wind has truly fallen below 15 miles per hour?

The most important question is how was it determined that 15 mile per hour winds are safe? Winds of that velocity and lower can easily disturb, entrain and carry beyond the property line small particles that are in the respirable size range--from about 5 microns down to sub-micron sizes.

The only safe way to conduct construction operations that will disturb contaminated soil is to do them under cover in movable buildings equipped with exhaust systems to maintain them under negative pressure. Enclosure 4 contains pages from a manufacturer's catalog that show buildings made of aluminum frames covered with heavy sheet materials made of reinforced plastic. They are easy to erect. They can be ordered in almost any size and roof height. They do not require concrete foundations. They can be readily moved and relocated. They will prevent the escape of fugitive dust from the work site to the environment.

CONTAMINANTS IN DRINKING WATER

The surface water runoff from 881 hillside as well as the ground water discharge into Woman Creek. Woman Creek delivers water to Mower Reservoir and Standley Lake which are used for agriculture and domestic water supplies. The waters from the 881 hillside are heavily contaminated. About 50 volatile organic compounds, inorganic compounds, and radioactive materials have been identified in the waters draining from the 881 hillside. Some of the materials are potent carcinogens. 29 of these contaminants are found in concentrations above the maximum allowable concentrations--ARARs, Applicable or Relevant and Appropriate Requirements.

The proposed removal of the contaminants applies only to those found in concentrations that are above the ARAR. It is proposed to reduce the concentrations of those treated materials to below the ARAR for each.

The proposed treatment is inadequate. It assumes that there are no additive or synergistic effects caused by combinations of contaminants.

To describe this most important danger of mixed contaminants, a description of the combined effect of asbestos exposure and cigarette smoking follows. The relationship of the effect of exposure to both those hazards is one of the most carefully studied phenomena in the field of industrial health. A person who does not smoke, nor is exposed to asbestos fibers, has small risk of contracting lung cancer. If that person is exposed to asbestos fibers over long periods of time, the risk of contracting lung cancer is four times as great as for the non-exposed individual. Someone who smokes regularly for some years has an increased risk of contracting lung cancer that is ten times as great as for individuals who neither smoked nor were exposed to asbestos fibers. What of the person exposed to both smoking **and** asbestos fiber? If the risks were additive, that doubly exposed individual would face a lung cancer risk that was 14 ($10 + 4$) times as great as that of the unexposed individual. The risk of lung cancer in people who both smoke and are exposed to asbestos fiber actually increases to **40 to 90** times the rate of those who were exposed to neither contaminant. That frightening fact illustrates the synergistic effects of multiple contaminant exposure. (Synergism is the phenomenon that results from the greatly enhanced effect produced by two biological agents acting together compared to each acting alone.)

Removing contaminants so that each is merely below the acceptable maximum completely neglects the synergistic effects of the 50 dangerous materials present in the 881 hillside water and even neglects the certainty that additive effects of the multiple contaminants exist.

The method of handling such a problem has been established by precedent. The "Code of Federal Regulations--Parts 1900 to 1910" §1910.1000, page 660, Title 29--Labor, Chapter XVII--Occupational Safety and Health Administration, shows exactly how this must be done in a workplace where healthy workers are exposed for eight hours per day:

(Enclosure 5 has pages reproduced from the code cited above. Although the code cited is for contaminants that are in air that is breathed, there is no difference in principle for considering the combined effects of multiple contaminants that are ingested in drinking water.)

In the left hand column, at the bottom of the page, appears the following formula:

"(2) (1) In case of a mixture of air contaminants an employer shall compute the equivalent exposure as follows:

$$E_m = (C_1 \div L_1 + C_2 \div L_2) + \dots (C_n \div L_n)$$

"where:

E_m is the equivalent exposure for the mixture.

C is the concentration for a particular contaminant.

L is the exposure limit for that contaminant, from table Z-1, Z-2, or Z-3."

$C_1 \div L_1$ is the fraction of the particular contaminant being considered with respect to its allowable concentration in the air breathed by workers. For example, if lead is present in the work place in an amount of $25 \mu\text{g}/\text{m}^3$ (micrograms per cubic meter) and the allowable limit is $50 \mu\text{g}/\text{m}^3$ then the fraction becomes $1/2$.

The rule states that the fractions for each of the contaminants added together cannot exceed one. If the result exceeds one then the employer is found to be in violation and cited and/or penalized. Thus, in the example shown above, if two other air borne contaminants are present in the air breathed by a worker and if each of those contaminants has a concentration only one-half of the allowable, the sum of all three fractions would be 1.5 and the employer would be in violation due to overexposing his workers to harmful contaminants. For the violation to cease the concentration of each of the three contaminants would have to be reduced to an average of no more than **one third of the maximum allowable** so that the combined fractional concentrations of all three added together did not exceed one.

What if there were fifty contaminants present in the air? That same rule would require that, on the average, each contaminant could not be present in a concentration that exceeded **one fiftieth** of the allowable.

If healthy workers must be protected this way in occupational settings where they are exposed for eight hours per day, how much more relevant to the case of contaminated water where populations of infants, children, the elderly, the infirm, and the sick will be exposed in their drink and in their food, any time during the day or night !!

The formula can be applied precisely the same way for the 50 known contaminants to be found in the groundwater of hillside 881. The concentration allowable for each contaminant must be reduced to 1/50th of the ARAR, on the average

The calculation given in the formula is very conservative. It accounts only for additive effects of each of the contaminants. As in the relationship of cigarette smoking, asbestos exposure, and lung cancer, the synergistic effects may produce deleterious health results that multiply the effects rather than simply add the effects.

CONCLUSION

The cleanup of 881 hillside shall not proceed until the three issues raised in this paper are studied and addressed.

ENCLOSURES

ENCLOSURE

1. 881 Hillside 1988 Surface Scrape Sampling Results
2. Page 112 of NIOSH Pocket Guide to Chemical Hazards
3. Regulations from OSHA for protecting workers from asbestos
4. Catalogue pages from a manufacturer of movable buildings
5. Pages from OSHA regulations for dealing with multiple contaminants to which workers are exposed

ENCLOSURE 1

TABLE 2-8

881 HILLSIDE 1988 SURFACE SCRAPE SAMPLING RESULTS

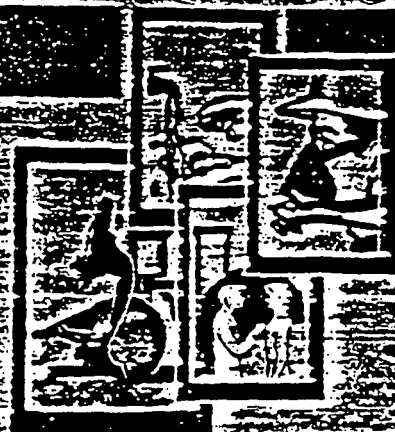
RADIONUCLIDE CONCENTRATION IN pCi/g

Sample No.	Uranium 233 + 234	Uranium 238	Plutonium
881-1	0.56±0.26	0.6±0.15	4.3±0.5
881-2	0.78±0.26	0.86±0.15	2.4±0.2
881-3	0.82±0.26	0.91±0.15	4.8±0.5
881-4	1.0±0.3	0.97±0.2	0.18±0.006
881-5	0.86±0.26	0.88±0.15	0.59±0.008
881-6	1.5±0.3	5.5±0.5	2.2±0.2
881-7	0.74±0.26	0.75±0.15	0.63±0.09
881-8	0.86±0.26	0.82±0.15	1.8±0.2
881-9	3.1±0.3	1.0±0.2	0.47±0.006
881-10	1.1±0.3	0.98±0.2	3.5±0.4
881-11	1.0±0.3	1.3±0.2	2.6±0.3
881-12	0.93±0.26	1.4±0.2	0.4±0.06
881-13	0.94±0.26	1.3±0.2	0.16±0.06
881-14	1.1±0.3	1.0±0.2	3.0±0.4
881-15	2.0±0.3	1.5±0.16	0.01±0.06
881-16	50±190	1300±100	0.3±0.06
881-17	19±74	590±70	0.78±0.19
881-18	60±230	3000±300	0.42±0.08
881-19	10±740	550±60	0.09±0.06

Data from: U. S. DOE, 1990b

NIOSH

POCKET GUIDE TO CHEMICAL HAZARDS



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

Chemical Name, Formula, CAS, RTECS, and DOT UN or NA and Guide Numbers	Synonyms	Exposure Limits	IDLH Level	Physical Description	Chemical and Physical Properties	Incompatibilities	Measurement Method (See Tables 1a and 1b)
Di-sec-octyl phthalate <chem>C18H34O4</chem> 117-81-7 T10350000	DOP, bis-(2-Ethylhexyl) phthalate, Di-2-Ethyl- hexyl phthalate, DEHP	5 mg/m ³ (NIOSH) Reduce expo- sure to lowest feasible limit See Appendix A	Ca	Colorless, oily liq- uid with almost no odor	MW: 390 BP: 727°F Sol: 0.005% FL.Proct: 425°F	VP: < 0.01 mm MP: -51°F UEL: ? LEL: ?	Nitrates; strong oxidizers, acids, and alkaloids Filter: CSL GC D
Dioxane <chem>OCH2CH2OCH2CH2</chem> 123-91-1 J68275000 1185 28	Dioxylene dioxide, Dioxylene ether, Dioxan, p-Dioxane, 1,4-Dioxane	100 ppm (360 mg/m ³) (NIOSH) 1 ppm 30-min cell See Appendix A (ACGIH) 25 ppm	Ca	Colorless liquid with a mild ether- like odor	MW: 88 BP: 214°F Sol: Miscible FL.P: 54°F IP: 9.13 eV	VP: 29 mm MP: 53°F UEL: 22% LEL: 2%	Strong oxidizers Char: CSL GC G
Dibenzyl <chem>C6H5CH2CH2C6H5</chem> 92-52-4 DU8050000	Benzyl, Phenyl benzene	0.2 ppm (1 mg/m ³)	300 mg/m ³	Colorless to pale yellow solid with a very characteristic odor	MW: 154 BP: 489°F Sol: Insoluble FL.P: 225°F IP: 8.27 eV	VP: Very low MP: 156°F UEL(111°F): 5.8% LEL(112°F): 0.6%	Oxidizers Tenax: CSL GC Set 4
Dibenzyl glycol monomethyl ether <chem>C6H5CH2CH2OCCH3</chem> 34590-94-8 JM1575000	Dibenzyl glycol monomethyl ether, Dowanol 50B	100 ppm (600 mg/m ³)	N.A.	Colorless liquid with a weak odor	MW: 148 BP: 274°F Sol: Miscible FL.P: 185°F	VP: 0.3 mm MP: -117°F UEL: ? LEL: ?	Strong oxidizers Char: CSL GC F

ENCLOSURE 2

and effective July 1, 1976. Time-weighted average air concentrations of asbestos fibers any employee may be exposed to shall not exceed two fibers, or 5 micrometers, per cubic foot of air, as determined by the method prescribed in paragraph (c) of this section.

Exposure concentration. No employee shall be exposed at any time to concentrations of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimeter, as determined by the method prescribed in paragraph (c) of this section.

Methods of compliance—(1) Engineering controls. (i) Engineering controls, such as, isolation, enclosure, ventilation, and dust collection, shall be used to meet the exposure limits prescribed in paragraph (b) of this section.

(ii) **Local exhaust ventilation.** (a) Exhaust ventilation and dust collection systems shall be designed, installed, and maintained in accordance with the American National Standards Institute Fundamentals Governing Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971, which is incorporated by reference herein.

(b) See § 1910.6 concerning the availability of a historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

Articulated tools. All hand-operated or power-operated tools which produce or release asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section shall, but not limited to, saws, grinders, abrasive wheels, and drills, be provided with local exhaust ventilation systems in accordance with the method prescribed in paragraph (ii) of this subparagraph.

Work practices—(1) Wet methods. As practicable, asbestos shall be wetted, mixed, applied, removed, or otherwise worked in a manner sufficient to prevent the release of airborne fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

usefulness of the product would be diminished thereby.

(ii) **Particular products and operations.** No asbestos cement, mortar, coating, grout, plaster, or similar material containing asbestos shall be removed from bags, cartons, or other containers in which they are shipped, without being either wetted, or enclosed, or ventilated so as to prevent effectively the release of airborne asbestos fibers in excess of the limits prescribed in paragraph (b) of this section.

(iii) **Spraying, demolition, or removal.** Employees engaged in the spraying of asbestos, the removal, or demolition of pipes, structures, or equipment covered or insulated with asbestos, and in the removal or demolition of asbestos insulation or coverings shall be provided with respiratory equipment in accordance with paragraph (d)(2)(iii) of this section and with special clothing in accordance with paragraph (d)(3) of this section.

(d) **Personal protective equipment—(1)** Compliance with the exposure limits prescribed by paragraph (b) of this section may not be achieved by the use of respirators or shift rotation of employees, except:

(i) During the time period necessary to install the engineering controls and to institute the work practices required by paragraph (c) of this section;

(ii) In work situations in which the methods prescribed in paragraph (c) of this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by paragraphs (d)(1) (i), (ii), or (iii) of this section, and both are practicable, personnel rotation shall be preferred and used.

(2) Where a respirator is permitted by paragraph (d)(1) of this section, it shall be selected from among those approved by the Bureau of Mines, Department of the Interior, or the National Institute for Occupational Safety and Health, Department of

Health, Education, and Welfare, under the provisions of 30 CFR Part 11 (37 FR 6244, Mar. 25, 1972), and shall be used in accordance with subdivisions (i), (ii), (iii), and (iv) of this subparagraph.

(i) **Air purifying respirators.** A reusable or single use air purifying respirator, or a respirator described in paragraph (d)(2) (ii) or (iii) of this section, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) **Powered air purifying respirators.** A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in paragraph (d)(2)(iii) of this section, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

(iii) **Type "C" supplied-air respirators, continuous flow or pressure-demand class.** A type "C" continuous flow or pressure-demand, supplied-air respirator shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed 100 times those limits.

(iv) **Establishment of a respirator program.** (a) The employer shall establish a respirator program in accordance with the requirements of the American National Standards Practices for Respiratory Protection, ANSI Z88.2-1969, which is incorporated by reference herein.

(b) See § 1910.6 concerning the availability of a historic file in connection therewith. The address of the

American National Standards Institute is given in § 1910.100.

(c) No employee shall be assigned to tasks requiring the use of respirators if, based upon his most recent examination, an examining physician determines that the employee will be unable to function normally wearing a respirator, or that the safety or health of the employee or other employees will be impaired by his use of a respirator. Such employee shall be rotated to another job or given the opportunity to transfer to a different position whose duties he is able to perform with the same employer, in the same geographical area and with the same seniority, status, and rate of pay he had just prior to such transfer, if such a different position is available.

(3) **Special clothing.** The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the ceiling level prescribed in paragraph (b) of this section.

(4) **Change rooms:** (i) At any fixed place of employment exposed to airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, the employer shall provide change rooms for employees working regularly at the place.

(ii) **Clothes lockers:** The employer shall provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from his work clothes.

(iii) **Laundering:** (a) Laundering of asbestos contaminated clothing shall be done so as to prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(b) Any employer who gives asbestos-contaminated clothing to another person for laundering shall inform such person of the requirement in paragraph (d)(4)(iii)(a) of this section to effectively prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

ENCLOSURE 3

aminated clothing shall be sealed in sealed impermeable other closed, impermeable and labeled in accordance with paragraph (g) of this section.

Method of measurement. All determinations of airborne concentrations of asbestos fibers shall be made by membrane filter method at 100X magnification (4 millimetre) with phase contrast illumination.

Monitoring—(1) Initial determination. Within 6 months of the publication of this section, every employer at every place of employment where asbestos fibers are released shall be required in such a way as to determine whether every employee's exposure to asbestos fibers is below the limits prescribed in paragraph (b) of this section. If the limits are exceeded, the employer shall immediately implement a compliance program in accordance with paragraph (c) of this section.

Personal monitoring—(1) Sampling. Samples shall be collected from within the breathing zone of the employees, on membrane filters of 0.8 micrometer diameter mounted in an open-face filter holder. Samples shall be taken for determination of the 8-hour time-weighted average airborne concentrations of asbestos fibers.

Sampling frequency and pattern. After the initial determinations required by paragraph (f)(1) of this section, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees. In no case shall sampling be done at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the limits prescribed by paragraph (b) of this section.

Environmental monitoring. (1) Samples shall be collected from areas of the work environment which are representative of the airborne concentrations of asbestos fibers which may be in the breathing zone of employees. Samples shall be collected on a membrane filter of 0.8 micrometer diameter mounted in an open-face filter holder. Samples shall be taken for the

determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by paragraph (f)(1) of this section, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of the employees. In no case shall sampling be at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the exposure limits prescribed in paragraph (b) of this section.

(4) Employee observation of monitoring. Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(g) Caution signs and labels—(1) Caution signs—(i) Posting. Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits prescribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) Sign specifications. The warning signs required by paragraph (g)(1)(i) of this section shall conform to the requirements of 20" x 14" vertical format signs specified in § 1910.145(d)(4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this subdivision.

Legend	Notation
Asbestos	1" Sans Serif, Gothic or Block.
Dust Hazard	½" Sans Serif, Gothic or Block.
Avoid Breathing Dust	¼" Gothic.
Wear Assigned Protective Equipment	¼" Gothic.

Legend	Notation
Do Not Remain In Area Unless Your Work Requires It.	¼" Gothic.
Breathing Asbestos Dust May Be Hazardous To Your Health.	14 point Gothic.

Spacing between lines shall be at least equal to the height of the upper of any two lines.

(2) Caution labels—(i) Labeling. Caution labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, blinder, or other material so that during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section will be released.

(ii) Label specifications. The caution labels required by paragraph (g)(2)(i) of this section shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

CAUTION

Contains Asbestos Fibers

Avoid Creating Dust

Breathing Asbestos Dust May Cause Serious Bodily Harm

(h) Housekeeping—(1) Cleaning. All external surfaces in any place of employment shall be maintained free of accumulations of asbestos fibers if, with their dispersion, there would be an excessive concentration.

(2) Waste disposal. Asbestos waste, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing, consigned for disposal, which may produce in any reasonably foreseeable use, handling, storage, processing, disposal, or transportation airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section shall be collected and disposed of in sealed impermeable bags, or other closed, impermeable containers.

(i) Recordkeeping—(1) Exposure records. Every employer shall main-

tain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least 20 years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health, and to authorized representatives of either.

(2) Access. Employee exposure records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(e) and (g)-(i).

(3) Employee notification. Any employee found to have been exposed at any time to airborne concentrations of asbestos fibers in excess of the limits prescribed in paragraph (b) of this section shall be notified in writing of the exposure as soon as practicable but not later than 5 days of the finding. The employee shall also be timely notified of the corrective action being taken.

(j) Medical examinations—(1) General. The employer shall provide or make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

(2) Preplacement. The employer shall provide or make available to each of his employees, within 30 calendar days following his first employment in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination, which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV₁).

(3) Annual examinations. On or before January 31, 1973, and at least annually thereafter, every employer shall provide, or make available, comprehensive medical examinations to each of his employees engaged in occupations exposed to airborne concentrations of asbestos fibers. Such annual examination shall include, as a minimum, a chest roentgenogram (posterior-

14 × 17 inches), a history of symptomatology of respiratory and pulmonary function include forced vital capacity and forced expiratory volume (FEV_{1.0}).

Termination of employment. The employer shall provide, or make available, in 30 calendar days before or after termination of employment of an employee engaged in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive examination which shall include a minimum, a chest roentgenogram (posterior-anterior 14 × 17 inch history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second.

Medical examinations. No medical examination is required of any employee if adequate records show that the employee has been examined in accordance with this paragraph within a 1-year period.

Medical records.—(1) Maintenance.—Employers of employees examined pursuant to this paragraph shall maintain complete and accurate records of all such medical examinations. Records shall be readily available to employers for at least 20 years.

Records of the medical examinations required by this paragraph.—(1) The employer shall provide upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(g)-(1). These records shall also be included upon the request to the Director of NIOSH. Any physician conducting a medical examination required by this paragraph shall furnish the employer of the examined employee all the information specified by this paragraph, and for medical information related to occupational exposure to asbestos.

Emergency temporary standard.—(1) *Scope.* The emergency temporary standard is pursuant to section 6(c) of the Act and applies to all workplaces where employees are exposed to

asbestos in all industries covered by the Act, including, general industry, construction and maritime. Except to the extent modified by this emergency temporary standard all provisions of § 1910.1001 remain in effect.

(2) *Permissible levels of exposure.* The 8-hour time-weighted average airborne concentration of asbestos fibers to which any employee may be exposed shall not exceed one-half (0.5) fiber, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) *Methods of compliance with the emergency temporary standard.* Notwithstanding any other requirements of this section, compliance with the reduced exposure limit of 0.5 f/cc shall be achieved by any feasible combination of engineering controls, work practices, and personal protective equipment and devices.

(4) *Employee information and training.*—(1) As soon as possible, but not later than thirty (30) days from the effective date of this emergency temporary standard, the employer shall institute a training program for all employees exposed to airborne concentrations of asbestos in excess of 0.5 f/cc, without regard to the use of respirators and shall assure their participation in the program during the effective period of this emergency temporary standard.

(2) The employer shall assure that each such employee is informed of the following:

(A) The health effects associated with asbestos exposure;

(B) The relationship between asbestos and smoking in producing lung cancer;

(C) The nature of operations which could result in exposure to asbestos and necessary protective steps to minimize exposure including, as applicable, engineering controls, work practices, respirators, housekeeping and protective clothing;

(D) The purpose, proper use, fitting instructions and limitations of respirators permitted by the standard; and

(E) A review of all the provisions contained in 1910.1001.

(5) *Respiratory protection during the ETS.* Notwithstanding any other

requirement of this section, where respirators are used to achieve the permissible exposure limit of 0.5 f/cc they shall be selected according to Table 1.

(6) *Warning signs during the ETS.* In addition to the requirements of paragraph (g)(1) of this section, legible signs warning of the health hazards of asbestos shall be provided and displayed at each location where airborne concentrations of asbestos fibers may exceed 0.5 f/cc.

TABLE 1—RESPIRATOR PROTECTION FOR AIRBORNE CONCENTRATIONS OF ASBESTOS

Airborne Concentration of Asbestos (TWA)	Required Respirator ¹
Not in excess of 5 f/cc (10 X PEL).	Reusable or single use air purifying respirator.
Not in excess of 50 f/cc (100 X PEL).	Full facepiece air purifying respirator, or a powered air purifying respirator.
Greater than 50 f/cc.....	A type "C" continuous flow or pressure demand, supplied air respirator.

¹ Respirators specified for high concentrations may be used at lower concentrations of asbestos.

(Approved by the Office of Management and Budget under control number 1218-0010)

(Secs. 8(b), 8(c) and 8(g) (84 Stat. 1593, 1599, 1600; 29 U.S.C. 655, 657), the Secretary of Labor's Order 8-76 (41 FR 25059) and 29 CFR Part 1911, Ch. XVII of Title 29; secs. 8(b), 8(c), 8(e) and 8(g). Pub. L. 91-596, 84 Stat. 1593, 1598, 1599, 1600; 29 U.S.C. 655, 657; sec. 107, Pub. L. 91-54, 83 Stat. 96 (40 U.S.C. 333); 29 CFR Part 1911, Secretary of Labor's Order No. 9-83 (48 FR 35736))

(39 FR 23502, June 27, 1974. Redesignated at 40 FR 27073, May 28, 1975, and amended at 41 FR 11505, Mar. 19, 1976; 45 FR 35281, May 23, 1980; 48 FR 51139, Nov. 4, 1983; 49 FR 18295, Apr. 30, 1984)

§ 1910.1002 Coal tar pitch volatiles; Interpretation of term.

As used in § 1910.1000 (Table Z-1), coal tar pitch volatiles include the fused polycyclic hydrocarbons which volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter. Asphalt (CAS 8052-42-4, and CAS 64742-03-4) is not covered under the "coal tar pitch volatiles" standard.

(48 FR 2768, Jan. 21, 1983)

§ 1910.1003 4-Nitrophenyl.

(a) *Scope and application.* (1) This section applies to any area in which 4-Nitrophenyl, Chemical Abstracts Service Registry Number 92933 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to trans-shipment in sealed containers, except for the labeling requirements under paragraphs (e) (2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of 4-Nitrophenyl.

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 µm particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of 4-Nitrophenyl. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

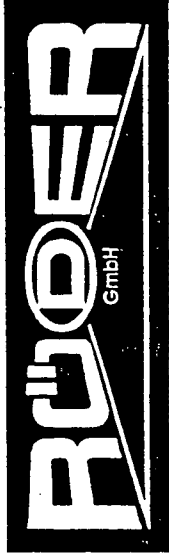
(4) "Closed system" means an operation involving 4-Nitrophenyl where containment prevents the release of 4-Nitrophenyl into regulated areas, non-regulated areas, or the external environment.

(5) "Decontamination" means the inactivation of 4-Nitrophenyl or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

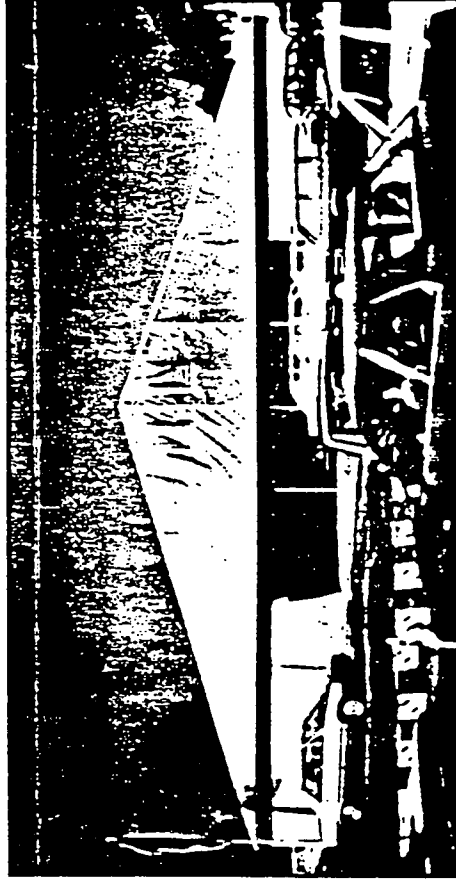
(7) "Disposal" means the safe removal of 4-Nitrophenyl from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of 4-Nitrophenyl which may result in exposure to or contact with 4-Nitrophenyl.

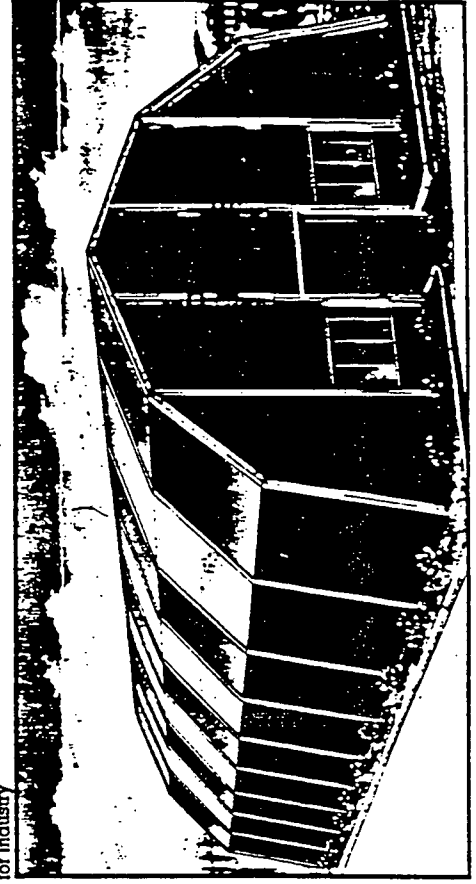


HALLS & TENTS

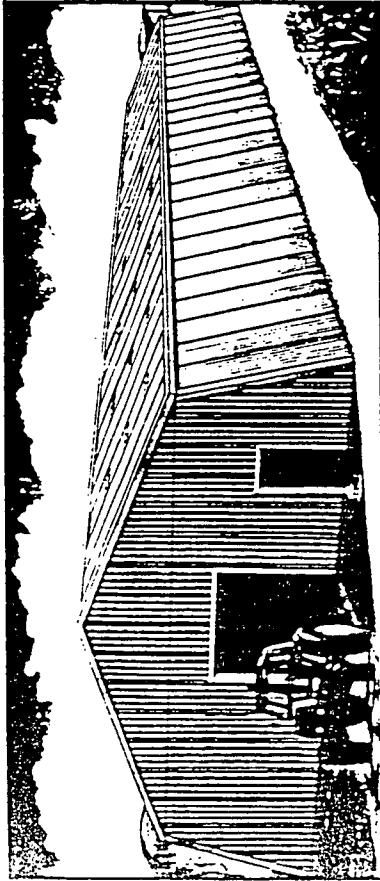
QUICK ASSEMBLY · SHORT DELIVERY DATE



for industry



for sports

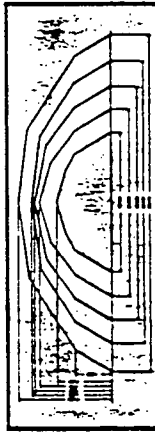
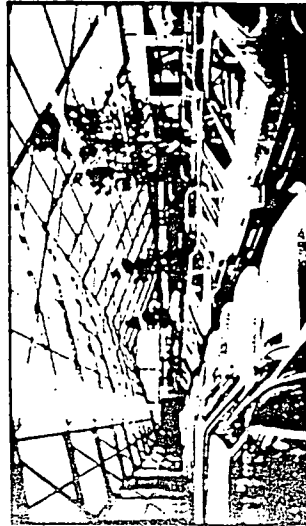


...also for
agriculture:

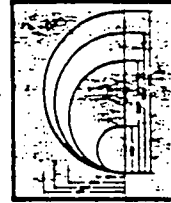
Exhibition and Storage tents

...extremely popular and sale-
promoting: our car tents.

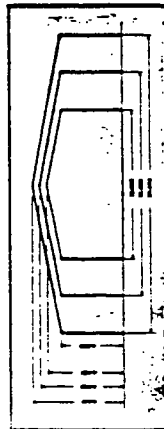
OUR PROGRAM:



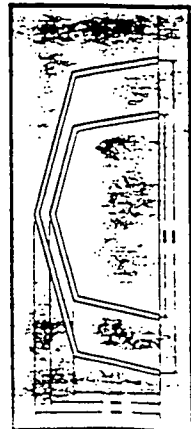
Polygonal hall type P
Technical data:
Minimum length 100 m
Rise length 80 m
Total length unlimited



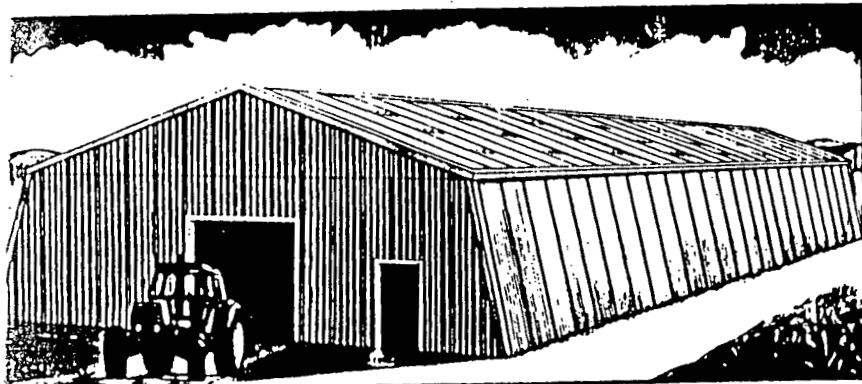
Round arch hall type R
Width and height according to
drawing; length unlimited.



Steel hall straight line type S1g
Technical data:
Minimum length 100 m
Rise length 50 m
Total length unlimited
Slope gradient 10°



Steel hall oblique type S1o
Technical data:
Minimum length 100 m
Rise length 50 m
Total length unlimited
Slope gradient 10°

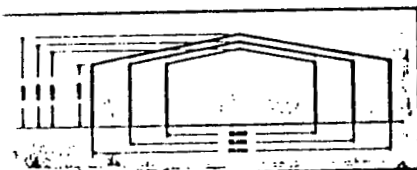


...also for
agriculture:

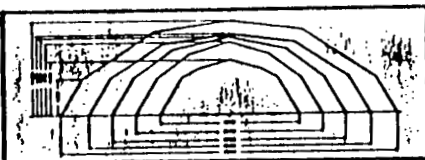
Exhibition and Storage tents

...extremely popular and sale-
promoting: our car tents.

OUR PROGRAM:



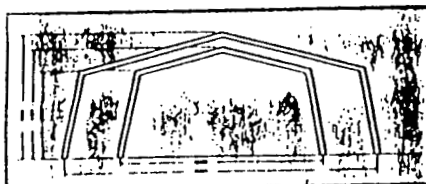
Steel hall straight-line type 81g
Technical data:
Minimum length: 100 m
Rafter length: 50 m
Total length: unlimited
Roof gradient: 10°



Polygonal hall type P
Technical data:
Minimum length: 100 m
Rafter length: 50 m
Total length: unlimited



Round-arch hall type R
Width and height according to
drawing, length unlimited



Steel hall oblique type 81e
Technical data:
Minimum length: 100 m
Rafter length: 50 m
Total length: unlimited



HALLS & TENTS

QUICK ASSEMBLY · SHORT DELIVERY DATE



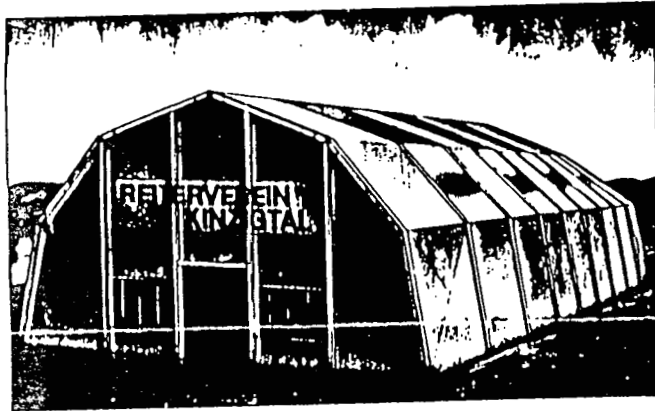
for industry



for sports

ENCLOSURE 4

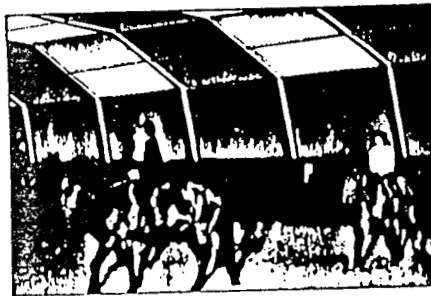
...SAFE...UNCOMPLICATED...GENEROUS DESIGN!



Sports halls — Sports tents

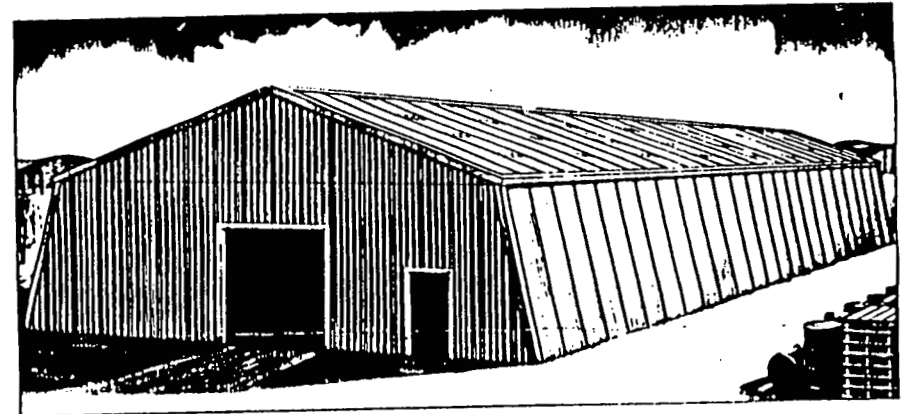
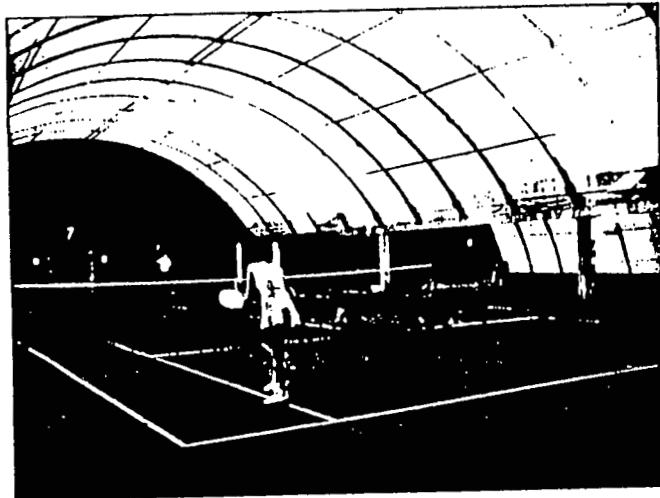
Stylishly designed polygonal halls of aluminum profiles with steel connecting elements.

Available with or without snow resistance; canvas covers or solid coverings optional; no foundations required.



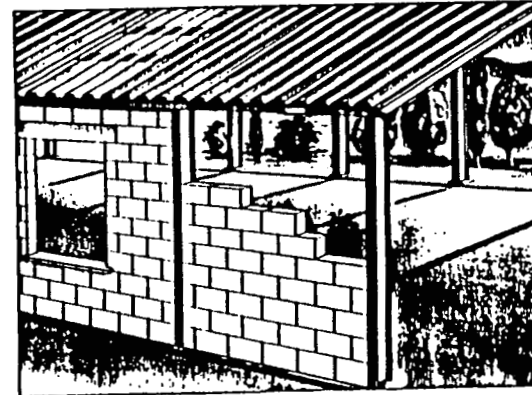
Round-arch halls of steel-tubing elements. Light airy canvas covers create the proper sports atmosphere; Also available with solid coverings.

Building permit enclosed. Repeated assembly possible.



Industrial halls — Industrial tents

Steel or Aluminum constructions for storage, exhibitions and production. Available with or without snow resistance; Coverings optional with aluminum-trapezium sheet metal or other solid materials; also with isolation; Low-priced, economical.



Exposure must be compensated by exposures to concentrations less than 10 p/m so that the cumulative exposure for the entire 8-hour work shift does not exceed a weighted average of 10 p/m.

Table Z-3: An employee's exposure to any material listed in table Z-1 on any 8-hour work shift of a 40-hour work week, shall not exceed the time weighted average limit for that material in the table.

Computation formulae:

(1) The cumulative exposure for our work shift shall be computed as follows:

$$E = C_1T_1 + C_2T_2 + \dots + C_nT_n \div 8$$

The equivalent exposure for the work shift.

Where the concentration during any period is C and the duration in hours of the exposure is T where the concentration remains constant.

The duration in hours of the exposure is T where the concentration remains constant.

The value of E shall not exceed the 8-hour time weighted average limit in table Z-1, Z-2, or Z-3 for the material exposed.

To illustrate the formula prescribed in paragraph (d)(1)(i) of this section, note that isoamyl acetate has a time weighted average limit of 10 p.p.m. (table Z-1). Assume that an employee is subject to the following exposure:

8 hours exposure at 150 p/m
4 hours exposure at 75 p/m
4 hours exposure at 50 p/m

Substituting this information in the formula, we have

$$150 \times 8 + 75 \times 4 + 50 \times 4 \div 8 = 81.25 \text{ p/m}$$

81.25 p.p.m. is less than 100 p.p.m., the 8-hour time weighted average limit, the exposure is acceptable.

(1) In case of a mixture of air contaminants an employer shall compute equivalent exposure as follows:

$$E = (C_1 \div L_1) + (C_2 \div L_2) + \dots + (C_n \div L_n)$$

Where E is the equivalent exposure for the work shift.

Where C is the concentration of a particular contaminant.

Where L is the exposure limit for that contaminant in table Z-1, Z-2, or Z-3.

The value of E_m shall not exceed unity (1).

(1) To illustrate the formula prescribed in paragraph (d)(2)(i) of this section, consider the following exposures:

Material	Actual concentration of 8-hour exposure	8-hour time weighted average limit
Acetone (Table Z-1)	500 p/m	1,000 p/m
2-Butanone (Table Z-1)	45 p/m	200 p/m
Toluene (Table Z-2)	40 p/m	200 p/m

Substituting in the formula, we have:

$$E_m = 500 \div 1,000 + 45 \div 200 + 40 \div 200$$

$$E_m = 0.500 + 0.225 + 0.200$$

$$E_m = 0.925$$

Since E_m is less than unity (1), the exposure combination is within acceptable limits.

(e) To achieve compliance with paragraph (a) through (d) of this section, administrative or engineering controls must first be determined and implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in this section. Any equipment and/or technical measures used for this purpose must be approved for each particular use by a competent industrial hygienist or other technically qualified person. Whenever respirators are used, their use shall comply with § 1910.134.

TABLE Z-1

Substance	p/m*	mg/M*
Acetaldehyde	200	100
Acetic acid	10	25
Acetic anhydride	5	25
Acetone	1,000	2,000
Acetonitrile	40	100
Acetylene dichloride, see 1, 2-Dichloroethylene		
Acetylene tetrabromide	1	10
Acrolein	0.1	0.25
Acrylamide—Skin		
Aldrin—Skin		
Allyl alcohol—Skin	2	1
Allyl chloride	1	1
C Allylglycidyl ether (AGE)	10	10
Allyl propyl disulfide	2	10

TABLE Z-1—Continued

Substance	p/m*	mg/M*
1-Propanol, see Ethanol		
1-Pyridine	0.5	2
1,2-Ethanedithiol	50	35
1,2-Ethanedithiol (Ammale)	15	15
1,2-Ethanedithiol	100	525
1,2-Ethanedithiol	125	650
1,2-Ethanedithiol	5	19
1,2-Ethanedithiol (o, p-isomers)—Skin	0.5	0.5
1,2-Ethanedithiol and compounds (as Sb)	0.3	0.3
1,2-Ethanedithiol (alpha naphthyl thiourea)		
1,2-Ethanedithiol organic compounds (as Ag)	0.05	0.5
1,2-Ethanedithiol	0.05	0.2
1,2-Ethanedithiol methyl—Skin	0.2	0.2
1,2-Ethanedithiol (soluble compounds)	0.5	0.5
1,2-Ethanedithiol, see Quinone		
1,2-Ethanedithiol peroxide	5	5
1,2-Ethanedithiol chloride	1	5
1,2-Ethanedithiol, see Diphenyl		
1,2-Ethanedithiol oxide	15	15
1,2-Ethanedithiol trifluoride	1	3
1,2-Ethanedithiol	0.1	0.7
1,2-Ethanedithiol—Skin	0.5	5
1,2-Ethanedithiol (1, 3-butadiene)	1,000	2,200
1,2-Ethanedithiol, see Butyl mercaptan		
1,2-Ethanedithiol	200	590
1,2-Ethanedithiol ethanol (Butyl Cello)		
1,2-Ethanedithiol—Skin	50	240
1,2-Ethanedithiol acetate (n-butyl acetate)	150	710
1,2-Ethanedithiol acetate	200	950
1,2-Ethanedithiol acetate	200	950
1,2-Ethanedithiol alcohol	100	300
1,2-Ethanedithiol alcohol	150	450
1,2-Ethanedithiol alcohol	100	300
1,2-Ethanedithiol—Skin	5	15
1,2-Ethanedithiol chromate (as CrO ₃)—Skin		
1,2-Ethanedithiol glycidyl ether (BGE)	50	270
1,2-Ethanedithiol mercaptan	10	35
1,2-Ethanedithiol, see Thiol		
1,2-Ethanedithiol oxide	10	60
1,2-Ethanedithiol oxide	5	5
1,2-Ethanedithiol (Sevin)	2	2
1,2-Ethanedithiol black	5	3.5
1,2-Ethanedithiol dioxide	5,000	9,000
1,2-Ethanedithiol monoxide	50	55
1,2-Ethanedithiol—Skin	0.5	0.5
1,2-Ethanedithiol camphene—Skin	0.5	0.5
1,2-Ethanedithiol diphenyl oxide	0.5	0.5
1,2-Ethanedithiol	1	3
1,2-Ethanedithiol dioxide	0.1	0.3
1,2-Ethanedithiol trifluoride	0.1	0.4
1,2-Ethanedithiol aldehyde	1	3
1,2-Ethanedithiol acetophenone (phenyl methyl ketone)	0.05	0.3
1,2-Ethanedithiol (monochlorobenzene)	75	350
1,2-Ethanedithiol benzene malononitrile	0.05	0.4
1,2-Ethanedithiol benzene	200	1,050
1,2-Ethanedithiol, see Chloro		
1,2-Ethanedithiol (42 percent Chloro)		
1,2-Ethanedithiol (54 percent Chloro)		
1,2-Ethanedithiol 2,1-Epoxypropane, see Epoxide		

TABLE Z-1—Continued

Substance	p/m*	mg/M*
2-Chloroethanol, see Ethylene chlorohydrin		
Chloroethylene, see Vinyl chloride		
C Chloroform (trichloromethane)	50	240
1-Chloro-1-nitropropane	20	100
Chloropicrin	0.1	0.7
Chloroprene (2-chloro-1,3-butadiene)—Skin	25	90
Chromium, sol. chromic, chromous salts as Cr		0.5
Metal and insol. salts		1
Coal tar pitch volatiles (benzene soluble fraction) anthracene, BaP, phenanthrene, acridine, chrysene, pyrene		0.2
Cobalt, metal fume and dust		0.1
Copper fume		0.1
Dusts and Mists		1
Cotton dust (raw)		10
Crag herbicide		15
Cresol (all isomers)—Skin	5	22
Crotonaldehyde	2	6
Cumene—Skin	50	245
Cyanide (as CN)—Skin		5
Cyclohexane	300	1,050
Cyclohexanol	50	200
Cyclohexanone	50	200
Cyclohexene	300	1,015
Cyclopentadiene	75	200
2,4-D		10
DDT—Skin		1
DDVP—Skin		1
Decaborane—Skin	0.05	0.3
Demeton—Skin		0.1
Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)	50	240
1,2-Diaminoethane, see Ethylene diamine		
Diazomethane	0.2	0.4
Diborane	0.1	0.1
Dibutyl phosphate	1	5
Dibutylphthalate		5
C o-Dichlorobenzene	50	300
p-Dichlorobenzene	75	450
Dichlorodifluoromethane	1,000	4,950
1,3-Dichloro-5,5-dimethyl hydantoin		0.2
1,1-Dichloroethane	100	400
1,2-Dichloroethylene	200	780
C Dichloroethyl ether—Skin	15	90
Dichloromethane, see Methylene chloride		
Dichloromono-fluoromethane	1,000	4,200
C 1,1-Dichloro-1-nitroethane	10	60
1,2-Dichloropropane, see Propylene dichloride		
Dichlorotetrafluoroethane	1,000	7,000
Dieldrin—Skin		0.25
Diethylamine	25	75
Diethylamino ethanol—Skin	10	50
Diethyl ether, see Ethyl ether		
Difluorodibromomethane	100	860
C Diglycidyl ether (DGE)	0.5	2.8
Dihydroxybenzene, see Hydroquinone		
Diisobutyl ketone	50	290
Diisopropylamine—Skin	5	20
Dimethoxymethane, see Methylal		
Dimethyl acetamide—Skin	10	35
Dimethylamine	10	18

ENCLOSURE 5